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PRODUCER REVENUE EFFECTS OF FEDERAL MARKETING ORDER QUALITY STANDARDS

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ABSTRACT

Most Federal marketing orders for fruits, vegetables, and horticultural specialties authorize setting minimum shipping standards for grades and sizes. In many orders, this is the only type of provision authorized that can influence commodity supplies. This study attempts to separately measure the supply-decreasing and demand-increasing effects of order imposed standards. A positive relationship between quality and demand was found in only 4 of the 17 commodities studied. For 9 other commodities, demand was inelastic in the vicinity of normal seasonal sales, suggesting that standards could be strengthened during years of heavy crops to prop producer revenues.

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Introduction

Enabling legislation for Federal marketing orders authorizes several means of promoting orderly marketing of fruit and vegetable crops. Some of these authorized provisions involve direct means of marketing control through intraseasonal handler prorates (e.g., California-Arizona citrus), producer allotments (hops) or separable market allocation (walnuts). Orders utilizing direct control provisions have been recently criticized for their price enhancement potential and negative effect on efficient resource allocation (Masson, Farmer Cooperative Service).

Quality standards imposed under Federal marketing orders have been subject to less public criticism, but may also serve to limit supplies. Moreover, they are more ubiquitous than direct supply control measures. In 1979, 43 of 45 Federal orders for fruit and vegetable crops authorized minimum size, grade, or maturity standards. In the case of 22 orders quality standards were the only provision permitted which may affect the level of sales (Jesse, p. 4-5).

Quality standards are applied with varying levels of activity with respect to frequency of change. Some order-imposed standards are nearly constant over time, apparently reflecting minimum trade acceptance as perceived by order committees. In other cases, size and grade standards are altered from season to season and within seasons, at least partly in response to changing crop size and quality composition.

The purpose of this study is to theoretically and empirically explore the effects of quality standards imposed under Federal orders for fruits and vegetables. Hypotheses concerning the incidence and impact of use are developed and tested. More specifically, standards are asserted to alter both supply and demand, and an attempt is made to quantify these separate effects.

Theoretical Effect of Standards

One method of analyzing quality restrictions involves defining separate demand relationships for each grade and size category eligible for sale (Farrell). Altering standards would then be manifested by changes in demand within an expanded or contracted set of interdependent relationships. Consider the following set of derived demands for a fresh fruit crop at shipping point:

$$P_j = f(Q_i,\ i = 1, \ldots n;\ Z)\quad j=1, \ldots, n$$

where

P_j = price for quality j

Q_i = quantity of i^{th} quality sold

Z = set of demand shifters

n = total number of identifiable size/grade categories saleable, ordered by decreasing quality.

$$\frac{\partial P_j}{\partial Q_i} < 0 \text{ for all } i, j$$

The magnitude and quality composition of saleable production in a given year along with minimum standards imposed (n) defines the quality category supplies (Q_i), total sales ($\sum_{i=1} Q_i = Q_T$), and the shipping point

price surface (P_j's). Average return to saleable fruit is $\bar{P} = \frac{\sum_{i=1}^{n} P_i Q_i}{Q_T}$

Specifying more stringent quality standards through marketing order action is equivalent to reducing n, which, in turn, reduces Q_T. Assuming more restrictive standards are applied to predetermined production:

$$n' < n$$

$$P_i' > P_i \text{ for } i \leq n'$$

$$Q_i' \equiv Q_i \text{ for } i \leq n'$$

$$Q_i' = 0 \text{ for } n \geq i > n'$$

$$\sum_{i=1}^{n'} Q_i' = Q_T' < \sum_{i=1}^{n} Q_i = Q_T$$

$$Q_T'\bar{P}' \lesseqqgtr Q_T\bar{P} \text{ if } \sum_{j=1}^{n'} \sum_{i=n'+1}^{n} \frac{\partial P_j}{\partial Q_i}(-Q_i) \lesseqqgtr \sum_{i=n'+1}^{n} P_i Q_i$$

where the prime superscripts indicate values with the more restrictive standards. Higher culling rates eliminate supplies in some categories eligible for sale under less-restrictive standards, raising prices through shifts in demand for the remaining categories of fruit. The effect on shipping point revenue is positive if and only if resulting increases in prices for saleable fruit lead to revenue gains large enough to compensate for losses in revenue in excluded categories. These price changes depend on the responsiveness of demand to the availability of (highly-substitutable) fruit in other quality categories.

While theoretically appealing, this formulation suffers from both operational and conceptual difficulties. Empirical estimation of demand for separate quality categories might be possible at wholesale or shipping

point, since quality distinctions and associated price differences typically exist at these points. However, published price data is seldom detailed enough to permit separate demand estimation, and for many horticultural commodities covered by size and grade marketing orders, only season-average grower returns are available from secondary sources. Even with appropriate price and quantity data, statistical separation of demand interdependencies would likely be fortuitous.

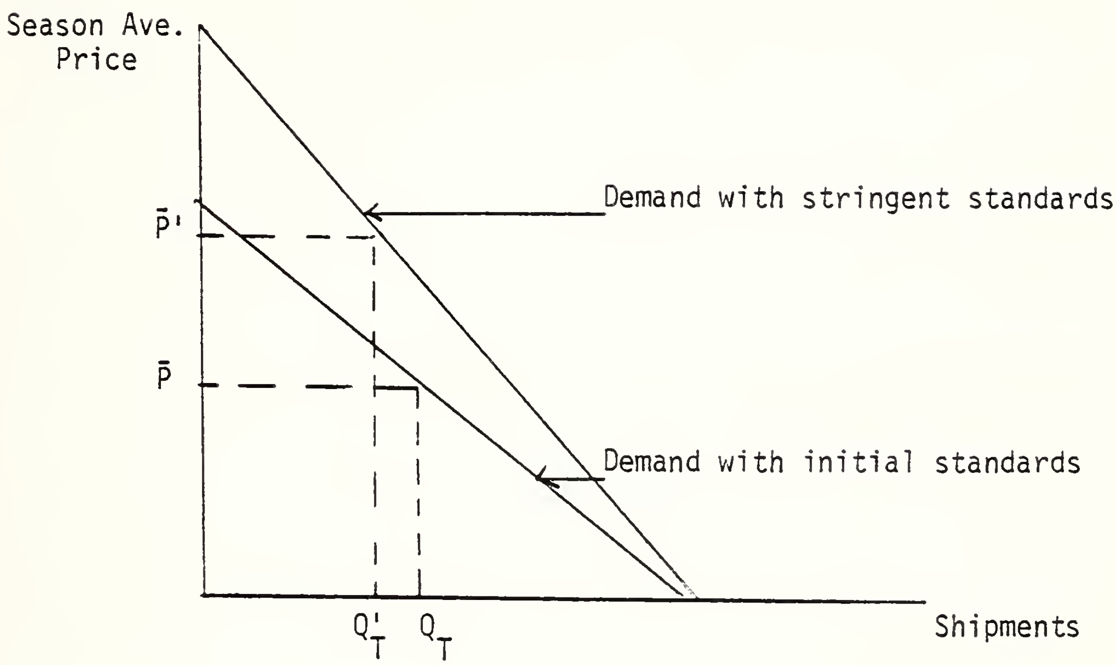
A more serious shortcoming of the theoretical specification above relates to the disappearance of quality distinctions at the retail level. Retailers may buy on the basis of quality, but produce on retail display is typically homogeneous. Consumers have little opportunity to express preferences among quality categories, except to the extent they are capable of discriminating quality differences among produce outlets.

A more tractable theoretical specification underlying some empirical work on the effect of produce quality on price (see Foote and Fox, p. 70-76) was explicitly identified by Price. Utilizing a continuous quality index, an aggregate derived demand relationship can be expressed as:

$$\bar{P} = f(Q_T, AQ, Z)$$

where AQ is an indicator of increasing quality with $\partial\bar{P}/\partial AQ > 0$ and the other variables are defined above. Given predetermined gross seasonal production and its quality characteristics, imposition of more restrictive quality standards in this formulation would increase AQ, decrease Q_T, and increase price. Such a change with a linear aggregate demand curve is illustrated below in Fig. 1.

Figure 1. Effect of Increasing Quality Standards



Shipments are reduced by the amount of production falling into the newly-restricted quality categories. Price increases both from the reduced quantity sold and from the demand increase associated with the increase in average quality. The difference in total revenue depends on the elasticity of demand as well as the quality-price relationship, and may be positive or negative.

Moving beyond the static single-season case, it would be expected that order administrative committees would alter quality according to crop size, applying more restrictive standards in years of heavy supplies.[1/] Incentives to increase culling rates would be greater; (1) the more inelastic aggregate demand and (2) the more responsive demand to average quality increases (see Price).

The aggregate demand formulation above recognizes the effect of quality on price without requiring interdependent demand functions. Data requirements for estimation are confined to published seasonal shipments and average prices and information on average quality.

<u>Observed Use of Marketing Order Quality Standards</u>

Based on the effects outlined above, active use of quality standards would be anticipated for commodities with an inelastic demand. If demand was elastic, the quantity-decreasing effect of higher culling would, by itself, reduce total returns to producers. But the associated demand shift due to higher quality could result in expanded total returns. Hence, active use of standards for commodities with an elastic demand would only be expected if a strong quality-price relationship existed.

To test these hypotheses, crude seasonal demand relationships were estimated for 17 commodities marketed under Federal orders employing quality standards. For 15 of these, quality standards were the only supply management provisions authorized. California-Arizona Navel and Valencia oranges were also included, though weekly prorates imposed on handlers are the primary economic provisions authorized in these orders.

Unpublished data on standards were obtained from the Fruit and Vegetable Division of USDA's Agricultural Marketing Service (AMS) for all fresh fruits and vegetables using quality standards imposed under Federal orders.[2/] Data for fruits (except for California-Arizona oranges) were available only from 1960. Vegetable data were obtained from 1952.

The quality data were used to construct a quality index (QI) for order crops which varied according to the degree of restrictiveness associated with the standards. Each year in which standards were used was ranked by relative restrictiveness. Years during which standards were not employed were assigned a value of zero. The year or years during which the weakest standard applied were assigned 1.0, and years with increasingly stringent standards were assigned successive integers. Then the largest value, n, was respecified as 10.0, with other values recalculated as their initial score weighted by 10.0/n.

Minimum size, grade, and other quality dimensions were specified in numerous ways in the order standards, necessitating a good deal of subjectivity in interpreting quality distinctions. The ranking procedure considered the amount of time during the season a set of standards was in effect as well as the indicated level of restrictiveness.

The index value reflects relative quality standards within individual commodities, but quality comparisons across commodities are not particularly meaningful.[3/]

The general form of the demand relationship estimated was:

$$\overline{P}_{i,t} = a_i + b_i Q_{i,t} + c_i NOQ_{i,t} + d_i INC_t + e_i QI_{i,t}$$

where

$\overline{P}$ = season average grower returns, dollars per unit of sale, deflated by the index of prices received by farmers, all commodities.[4/]

Q = quantity marketed under order, pounds per-capita[5/]

NOQ = competing supplies not marketed under order, pounds per-capita

INC = per-capita U.S. disposable income deflated by the Consumer Price Index.

QI = quality index as defined above

i = commodity

t = season

Initially, 35 commodities were considered in the analysis. Ten fresh fruits were dropped because the standards were too complex to permit definition of indexes. Typically, these involved multiple varieties or multiple production areas with different, inconsistent standards for each. Six commodities were dropped because the standards were either constant or changed only once or twice during the data period. Two commodities were excluded because applicable Federal orders had been in effect for only a few years.

The estimated demand relationships for the 17 remaining commodities are shown in Table 1. Estimates were first obtained excluding the quality

index as an explanatory variable. Some modifications in the set of independent variables and re-estimates were made of this stage. Competing quantity was dropped if its coefficient was not significant at the 90 percent level or if its sign was positive. Income was retained regardless of coefficient sign or significance except where its inclusion precluded obtaining a significant negative coefficient on own quantity. In the case of four commodities, it was necessary to aggregate order and non-order production to achieve a significant negative coefficient on quantity. For these commodities, coefficient and price flexibility values must be interpreted under the assumption of constant proportional quantity and quality changes between order and non-order producing areas in order to be comparable to those estimated in the other formulations.[6/]

The quality index was then added to the modified set of explanatory variables and the demand relationships reestimated. Three measures of the significance of the added variable are shown in Table 1; the t-value of the quality index coefficient, the change in $\bar{R}^2$ from adding the index and the change in the standard error of estimate.

Using a weak retention criterion that either adjusted R^2 or standard error of estimate must improve with inclusion of the quality index with no deterioration of the other, the index is judged significant in only eight of the 17 commodity relationships. In four of these (including the three with the highest absolute t-values for the quality index coefficients, the coefficient sign is negative, suggesting a quality-demand relationship opposite expectations. There are several possible explanations for these perverse results. In the case of potatoes, prices reflect table stock as well as processing sales. While table stock demand may be

Table 1.--Estimated seasonal fruit and vegetable demand relationships with and without quality index

Commodity	No. of Observations	Int.	Prod. Under Order	Competing Prod. 1/	Income	Quality Index	R^2	$\Delta\bar{R}^2$ 2/	ΔSEE 3/
Texas Oranges	17	7.135	-1.196 (-2.58) 4/	-.030 (-2.00)	-.595 (-.89)		.87		
		7.097	-1.175 (-1.44)	-.030 (-1.49)	-.567 (-.50)	-.004 (-.03)	.87	-.01	.00
Texas Grapefruit	17	6.257	-1.180 (-5.18)	-.386 (-2.21)	.340 (.68)		.76		
		6.168	-1.135 (-4.69)	-.433 (-2.26)	.598 (.94)	-.057 (-.67)	.77	-.01	.02
Calif.-Az. Navels	24	16.533	- .998 (-11.05)	-.170 (-2.81)	-1.985 (-4.00)		.91		
		16.556	-1.002 (-10.28)	-.173 (-2.62)	-1.981 (-3.88)	.006 (.13)	.91	.00	.02
Calif.-Az. Valencias	24	15.935	- .857 (-8.90)	---	-2.827 (-9.13)		.84		
		16.419	- .913 (-8.94)	---	-3.016 (-9.11)	.065 (1.41)	.86	.02	-.01
Georgia Peaches	17	10.264	-6.095 (-4.23)	---	1.018 (.73)		.75		
		10.223	-5.987 (-3.71)	---	1.075 (.73)	-.035 (-.17)	.75	-.02	.06
Washington Peaches	17	14.508	-4.756 (-1.24)	-.784 (-2.05)	---		.51		
		10.340	-6.296 (-1.64)	-.321 (-.66)	---	.249 (1.48)	.58	.04	-.07
Calif. Bartlett Pears	13	17.581	-8.497 (-5.45)	-2.402 (-2.39)	-.828 (-.78)		.90		
		17.582	-8.500 (-4.62)	-2.403 (-2.24)	-.828 (-.74)	.000 (.00)	.90	-.02	.05

Table 1.--Continued

Commodity	No. of Observations	Int.	Prod. Under Order	Competing Prod. 1/	Income	Quality Index	R^2	$\Delta\bar{R}^2$ 2/	ΔSEE 3/
Washington-Oregon Bartlett Pears	11	15.321	-5.942 (-1.86)	-3.537 (-3.66)	---		.82		
		14.402	-4.903 (-1.33)	-3.097 (-2.54)	---	-.092 (-.64)	.83	-.02	.03
Washington-Idaho-Oregon Fresh Prunes	14	23.873	-25.661 (-3.94)	---	-3.307 (-3.14)		.62		
		21.856	-24.249 (-3.66)	---	-2.174 (-1.43)	-.238 (-1.04)	.65	.00	.00
Washington Apricots	20	14.499	-83.921 (-6.57)	---	---		.71		
		13.762	-80.384 (-4.91)	---	---	-.070 (-.36)	.71	-.02	.04
Idaho-Oregon Potatoes	25	2.250	-.078 (-4.03)	-.042 (-3.48)	2.078 (5.54)		.61		
		1.895	-.089 (-4.56)	-.046 (-3.89)	2.343 (6.03)	.056 (1.76)	.66	.04	-.01
Washington Potatoes	25	2.638	-.030 5/ (-2.52)	---	.885 (2.20)		.22		
		2.919	-.022 5/ (-1.92)	---	.526 (1.36)	-.078 (-2.51)	.40	.17	-.04
Oregon-No. California Potatoes	25	4.557	-.083 (-1.26)	-.072 (-4.73)	2.234 (5.50)		.63		
		4.701	-.155 (-2.95)	-.061 (-5.18)	2.172 (7.08)	-.092 (-4.12)	.80	.18	-.11
Colorado Potatoes	25	7.341	-.482 (-4.29)	-.025 (-3.84)	---		.50		
		8.707	-.407 (-4.67)	-.036 (-6.43)	---	-.138 (-4.19)	.73	.24	-.10

Continued--

Table 1.--Continued

Commodity	No. of Observations	Int.	Prod. Under Order	Competing Prod. 1/	Income	Quality Index	R^2	$\Delta\bar{R}^2$ 2/	ΔSEE 3/
Idaho-Oregon Onions	20	9.487	-1.130 5/ (-3.05)	---	2.182 (3.78)		.50		
		9.007	-1.063 5/ (-2.71)	---	2.240 (3.97)	-.067 (-.62)	.51	-.02	.01
Texas Valley Tomatoes	18	11.441	-1.461 5/ (-2.52)	---	2.543 (1.73)		.64		
		20.240	-1.670 5/ (-2.80)	---	.023 (.01)	-.285 (-1.22)	.68	.02	-.02
Florida Tomatoes	22	14.128	-.682 5/ (-2.60)	---	---		.25		
		13.664	-.583 5/ (-2.78)	---	---	.152 (1.95)	.38	.10	-.08

1/ Competing production as follows:

Texas oranges--All U.S. oranges for processing plus U.S. fresh oranges from outside order area.
Texas grapefruit--U.S. fresh grapefruit from outside order area.
California-Arizona Navels--Florida fresh oranges.
Peaches--U.S. fresh peaches from outside order area.
Pears--U.S. fresh pears from outside order area.
Potatoes--U.S. fall crop potatoes for all uses from outside order area.

2/ Adjusted R^2 with quality index as an explanatory variable minus adjusted R^2 with index excluded.

3/ Standard error of estimate with quality index as an explanatory variable minus standard error of estimate with index excluded.

4/ Figures in parentheses are t-values.

5/ Production includes all U.S. seasonal production, both within and outside area covered by order.

positively influenced by increases in quality, higher standards in years of large crops would result in proportionately larger processing and nonfood use diversion, reducing average price levels. The index may also be more closely related to overall crop quality than crop size. Ceteris Paribus, stringent fresh shipping standards may be imposed to force more of a low quality crop into alternative channels. It is also possible that the correlation between sales and QI is strong enough to preclude separation of quality and quantity effects on price. Finally, crop size may have an effect on price independent of quantity actually available for sale subsequent to culling. For example, "market tone" might be generally depressed with an abnormally large crop based on preharvest and harvest production forecasts. High culling rates would influence marketings, but resulting sales could yield prices below what the same level of sales would yield with a smaller total crop (even though quality is higher in the first case). A possible adjustment for this phenomenon, not attempted in this analysis, would involve including forecasts of total production as an explanatory variable in the demand relationships.

In the four relationships with a positive QI coefficient judged significant, price changes with one-unit changes in QI ranged from 1.4 (California-Arizona Valencia oranges) to 3.2 (Idaho-Oregon potatoes) percent of mean values. Expressed differently, moving from the least restrictive to the most restrictive standards given, fixed sales would increase price by 12.5 to 27 percent. This is in addition to the effect of quality standards on saleable supply.

Table 2 shows price flexibility values at various levels of sales for the 17 study commodities. Flexibilities are based on mean values of

Table 2.--Price flexibilities of demand relationships at selected levels of sales

Commodity	Form[1/]	Price flexibility at quantity equal to			Quantity Change Yielding F_p = 1.0[2/]
		$\bar{X}$ - SD	$\bar{X}$	$\bar{X}$ + SD	
Texas oranges	E	.21	.48	.92	1.14
Texas grapefruit	E	.32	.91	2.49	.09
Calif.-Az. navels	E	.72	1.25	2.26	- .41
Calif.-Az. valencias	I	.65	1.17	2.15	- .27
Georgia peaches	E	.26	.58	1.12	.82
Washington peaches	I	.05	.17	.32	3.66
California pears	E	.44	.85	1.58	.26
Wash.-Oreg. pears	E	.37	.56	.80	1.62
Wash.-Ida.-Oreg. prunes	E	.62	.91	1.31	.27
Wa. apricots	E	.10	.33	.70	1.55
Ida-Oreg. potatoes	I	.84	1.58	3.31	- .73
Wa. Potatoes	I	1.14	1.61	2.33	-1.39
Oreg.-N. Calif. potatoes	I	.33	.54	.82	1.49
Colorado potatoes	I	.94	1.34	1.95	- .83
Ida.-Oreg. onions	E	2.44	3.09	4.04	-5.53
Texas tomatoes	I	.72	1.00	1.38	0.00
Florida tomatoes	I	.32	.42	.53	4.02

[1/] E = Quality index excluded; I = quality index included.

[2/] Expressed as number of standard deviations from mean quantity over estimation period.

explanatory variables other than own quantity, where the relationships include the quality index only if judged significant. In general, the values support the hypotheses discussed above. Restricting sales through more stringent quality standards would increase total producer revenue based on mean sales levels in the six cases where price flexibility values exceed 1.0. In five other cases, price flexibility exceeds 1.0 at sales levels less than one standard deviation above mean levels. This suggests that quality standards might be strengthened in seasons with large crops and relaxed when production is normal or short. For two commodities, price flexibility is well below 1.0 around observed seasonal sales levels, but the quality index coefficient is positive. Hence, while the supply-decreasing effect of higher quality standards would tend to reduce grower returns in these cases, associated demand increases would be price-enhancing.

Four commodities exhibit both price flexibilities and QI coefficient values inconsistent with a priori expectations. At sales levels within one standard deviation of mean sales, restricting supplies would diminish returns, and demand is insensitive to quality variations as measured by QI. In these cases, the model may be inappropriate or the major reasons for employing grade and size restrictions may be other than revenue considerations. These might be handler preferences not fully reflected by price, or attempts to respond to changing tastes and preferences of consumers.

Conclusions

Variable quality standards self-imposed by producers marketing fruits and vegetables under Federal marketing orders would be expected to affect

both supply and demand. The supply-reducing effect of increasingly stringent standards suggests their active use with an inelastic grower-level demand. But even with an elastic demand, quality increases could increase demand enough to overcompensate revenue losses associated with decreased sales.

The effect of quality standards was explored by incorporating a quality index in seasonal demand relationships for 17 fresh fruits and vegetables marketed under Federal orders. A positive quality-demand influence was detected in only four commodities. But for 9 other commodities, demand was inelastic in the vicinity of average seasonal sales, suggesting standards could be increased in years of heavy crops to prop producer revenues. In the case of the other four commodities, the estimated relationships showed both an elastic demand and a negative or insignificant quantity-demand effect, suggesting that altering standards for these items has little positive effect on prices or revenue.

The results are summarized below classified according to price flexibilities and the quality index coefficient. The incentive for actively employing varying standards would be greatest for commodities in the northwest quadrant. Crop size would be an important consideration in applying standards to commodities in the northeast quadrant. The magnitude of the demand shift associated with quality changes would be the critical factor in the southwest quadrant. Based on estimated coefficients, quality standard increases for commodities falling in the southeast quadrant would not increase demand, and associated supply reductions would not increase producer gross revenue.

Table 3.--Commodities with order-imposed quality standards classified by estimated price flexibilities and quality-demand effect

Price Flexibility at sales less than mean sales plus one standard deviation	Change in Demand With Increasing Quality	
	Positive	Zero or Negative
$\geqq 1.0$	California-Arizona Valencia Oranges Idaho-Oregon Potatoes	Texas Grapefruit California-Arizona Navel Oranges Georgia Peaches California Bartlett Pears Washington-Idaho-Oregon Fresh Prunes Washington Potatoes Colorado Potatoes Idaho-Oregon Onions Texas Valley Tomatoes
<1.0	Washington Peaches Florida Tomatoes	Texas Oranges Washington-Oregon Bartlett Pears Washington Apricots S. Oregon-N. California Potatoes

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FOOTNOTES

1/ But note that crop size and quality may be positively correlated -- large crops are often high-quality crops. High quality standards applied in years of large crops may remove a smaller absolute quantity than more lenient standards in a short crop year. Consequently, high quality standards do not necessarily reflect high culling rates.

2/ Some specialty crop (dried fruits, tree nuts, and hops) orders also permit imposition of quality standards, but are largely dependent on surplus removal provisions to reduce supplies. Three processed fruit crops are also covered by Federal orders. Cranberries and tart cherries utilize a reserve pool, and do not employ size and grade standard except for reserve fruit. Olives were omitted from the analysis because of the complexity of the quality standards used.

3/ A free form specification of the effect of quality on demand using dummy variables would be preferable to the forced linear specification. This would permit identification of nonlinear influences or threshold points (e.g., below some level of quality, changes have no effect on demand). This approach was not employed because n, the number of distinguishable levels of quality, was typically quite close to the number of observations used to estimate the demand relationships.

4/ Published prices nearest the producer level were used. These were on-tree prices for citrus and returns at packing house door for most other commodities.

[5] Statistical Reporting Service (SRS, USDA) production estimates. Quantity is fresh market utilization except for potatoes and onions where production for all uses is included. Descriptions of how production estimates are derived suggest that reported quantity is quantity sold, and hence, excludes production not marketed because of quality standards imposed under marketing orders. (See Statistical Reporting Service.)

[6] An additional modification involves the Texas and Florida winter tomato relationships, which are misspecified since Mexican imports represent an important competing supply. Inclusion of Mexican imports resulted in insignificant coefficients on own quantity, and imports showed a significant positive sign. Imports are price-sensitive, and a simultaneous equation representation of the system is necessary to properly capture the dynamics.